Columbia University

DEPARTMENT OF PHYSICS

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June 3, 1983

Dr. Leon Lederman
Director
FERMILAB, P.O.Box 500
Batavia, IL 60510

Dear Leon:

This letter of intent is written to express the interest of our group to do a run using the 15-ft bubble chamber in the narrow band ν and $\bar{\nu}$ beam at Tevatron II. The run could occur simultaneously with the narrow band running of the counter experiments E649 and E652. We understand that this narrow band run is now scheduled to follow the broad band beam run for E632 using the 15-ft bubble chamber, so that it would not be a large effort on the part of the laboratory to keep the chambers sensitive for the narrow band run.

We believe that such a run would be interesting for a number of reasons:

1. We expect to have our holographic photography scheme installed and working in the 15-ft chamber for this run. As you know, our holography tests at Columbia were successful, and our apparatus is now installed in BEBC at CERN for a real life test, which is in progress right now. We have obtained good holograms of 100 μ glass beads in empty BEBC. The chamber is now cold and filled with a neon-hydrogen mix with the magnetic field on. We have fired the pulsed ruby laser into the cold, sensitive liquid and found no adverse effects (this settles our biggest worry!). And just today (Friday, June 3rd), we have obtained very clear holograms of actual cosmic ray tracks in BEBC, with a heavy neon-hydrogen mix and the full magnetic field. We now believe that the rest of the development is down to engineering detail, and we feel confident at this time that we will be able to photograph 100 μ diameter bubbles with a corresponding measuring resolution of $\sim$ 30 μ (i.e. 1/3 the bubble size).

2. We are now finishing our analysis of the neutral current events in our last narrow band run (E380). We find that we can actually reconstruct the momentum and angle of

9 pgs.

Dr. Leon M. Lederman
Director, FERMILAB

the outgoing neutrino on an event by event basis (we get the outgoing ν momentum to $\pm$ 15%!!). This allows us to calculate the scaling variables for each event (x with $\sim$ 0.085, y with $\sim$ 0.04 resolution!). We enclose a copy of the transparencies from a talk we gave at the Baltimore APS Meeting on these results. Our x distribution for neutral current events is considerably better than the latest results presented by the CHARM experiment at CERN, even though they have $\sim$ 8 times our statistics (they do not get the outgoing ν direction, and therefore x, for individual events, but do a statistical analysis which increases their systematic errors considerably). We further find that we can measure and reconstruct high energy events (much of the E380 run was with a 250 GeV focus) with very small losses. We therefore feel confident that we can do significant neutral current physics at the Tevatron for which we feel a narrow band beam is essential. With both ν and $\bar{\nu}$ running, we can also make a contribution to the structure function analysis in both neutral and charged current events, where the 4π acceptance of the chamber may supplement the counter experiments in regions where they have poor acceptance. Such a run would also provide a large sample of very high energy ν events with which we could look for unusual features in final states with $e^{\pm}$, μe, etc. using the good $e^{\pm}$ efficiency of the neon chamber and the good vertex resolution with the holography.

In addition to the anticipated physics results from a Tevatron narrow band run, we would gain valuable experience with our holographic scan tables and analysis procedures by doing an actual physics experiment prior to our tau neutrino search experiment.

With best regards,

Charlie

Charles Baltay

Talk presented at 1983
Baltimore APS meeting.

Distributions in the Scaling Variables X and Y in Neutral Current ν_μ Interactions

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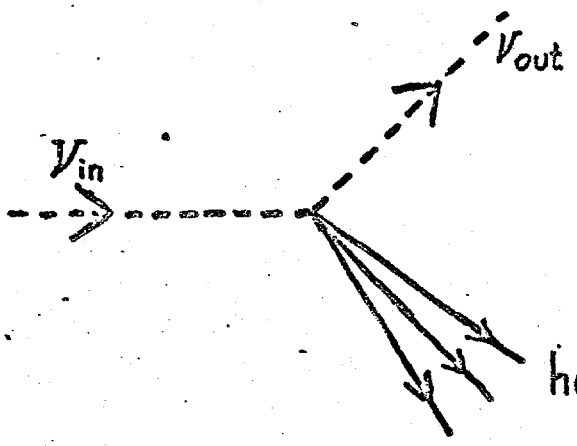
Lepton Reconstruction :



NC event

$$\begin{cases} E_{\nu,out} = E_{\nu,in} + m_p - E_{had} \\ \vec{P}_{\nu,out} = \vec{P}_{\nu,in} - \vec{P}_{had} \end{cases}$$

We know

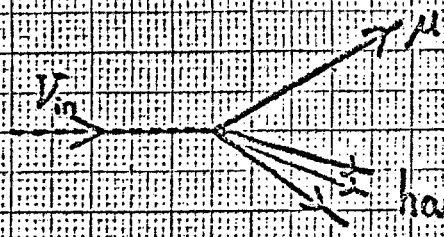
$E_{\nu,in}$, $\vec{P}_{\nu,in}$ from neutrino beam .

We measure

E_{had} , $\vec{P}_{had}$

We can reconstruct the unmeasureable outgoing ν.

Using CC events, we can check the resolution of lepton reconstruction systematically.

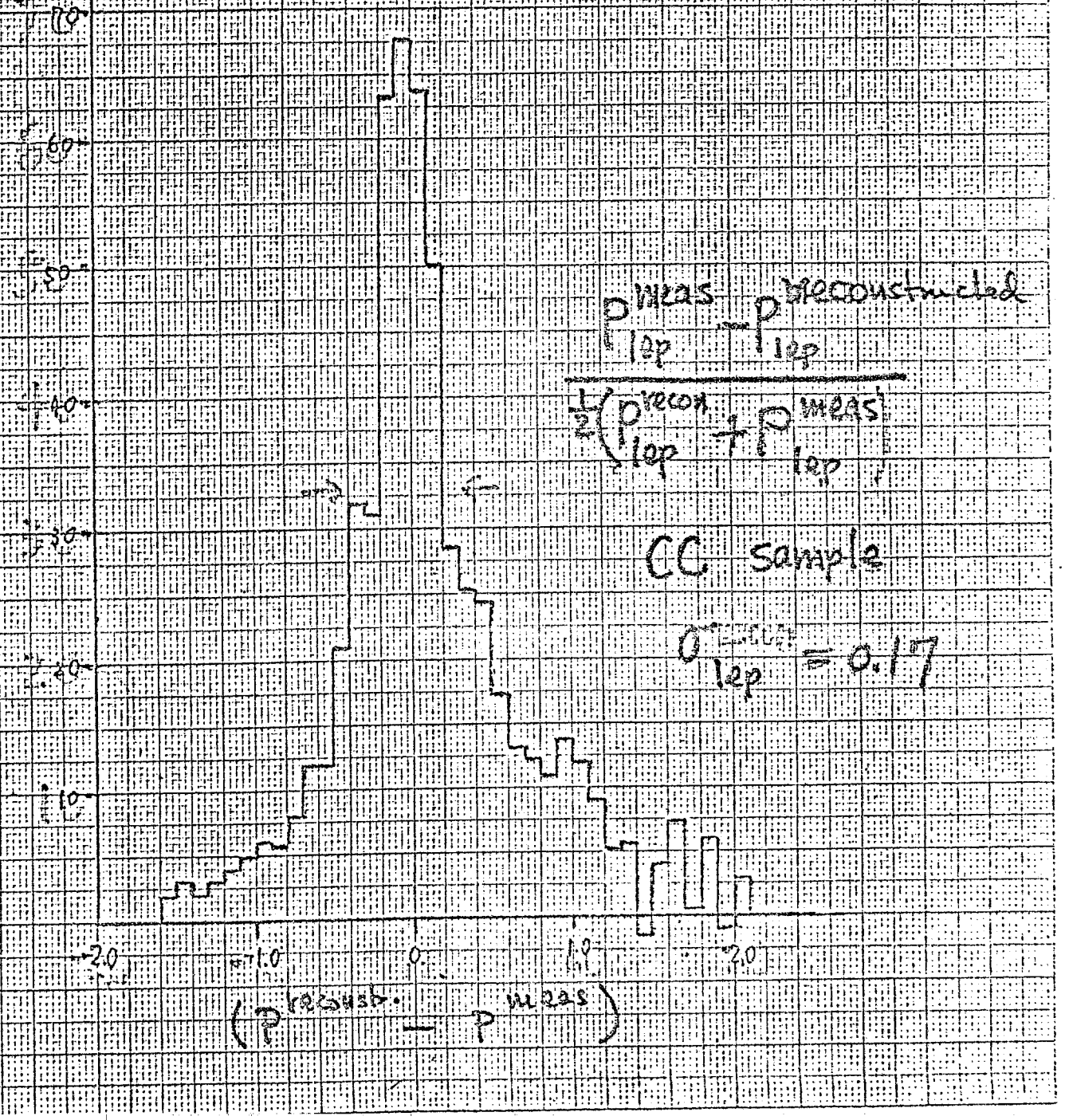


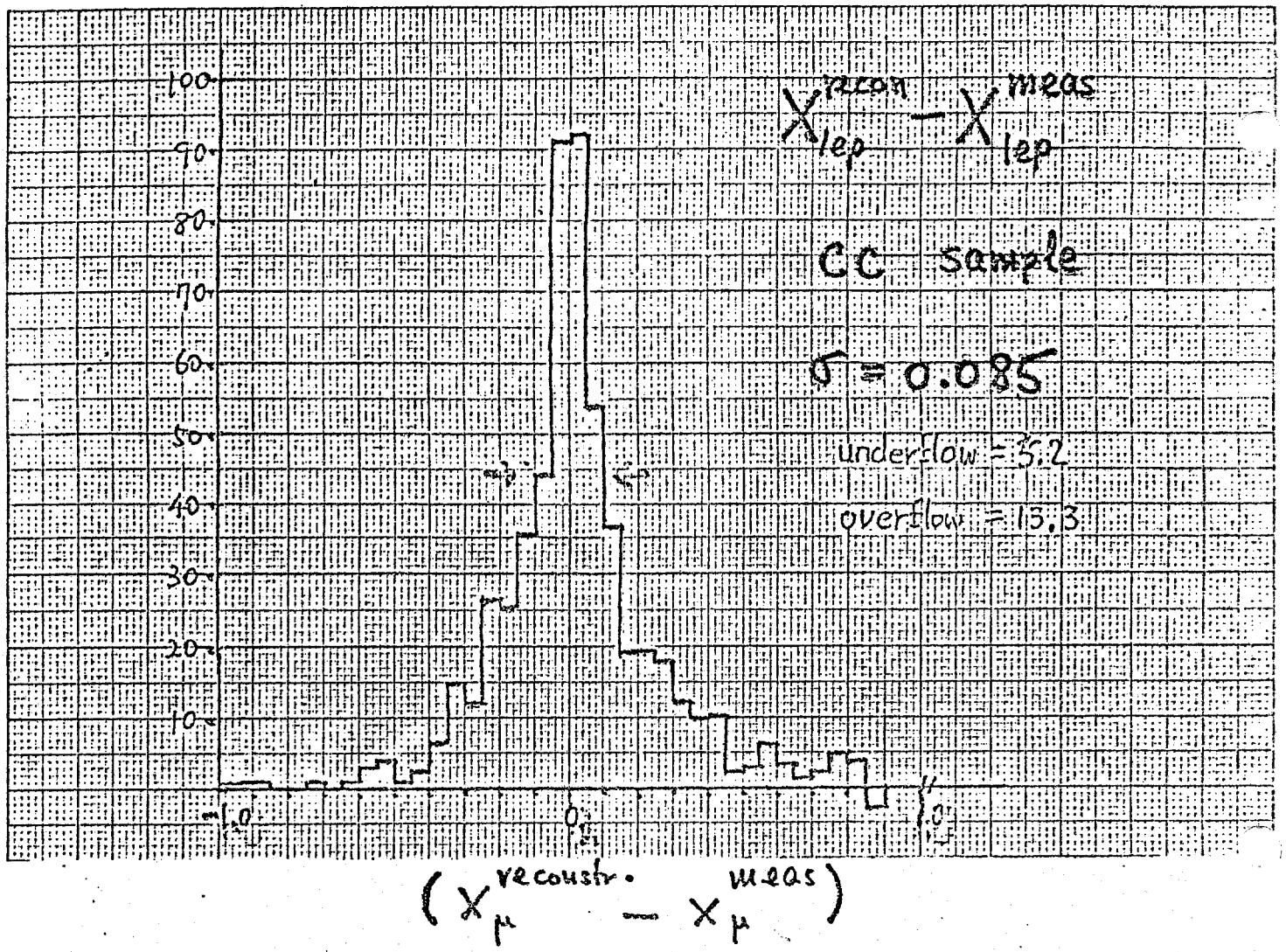
CC event

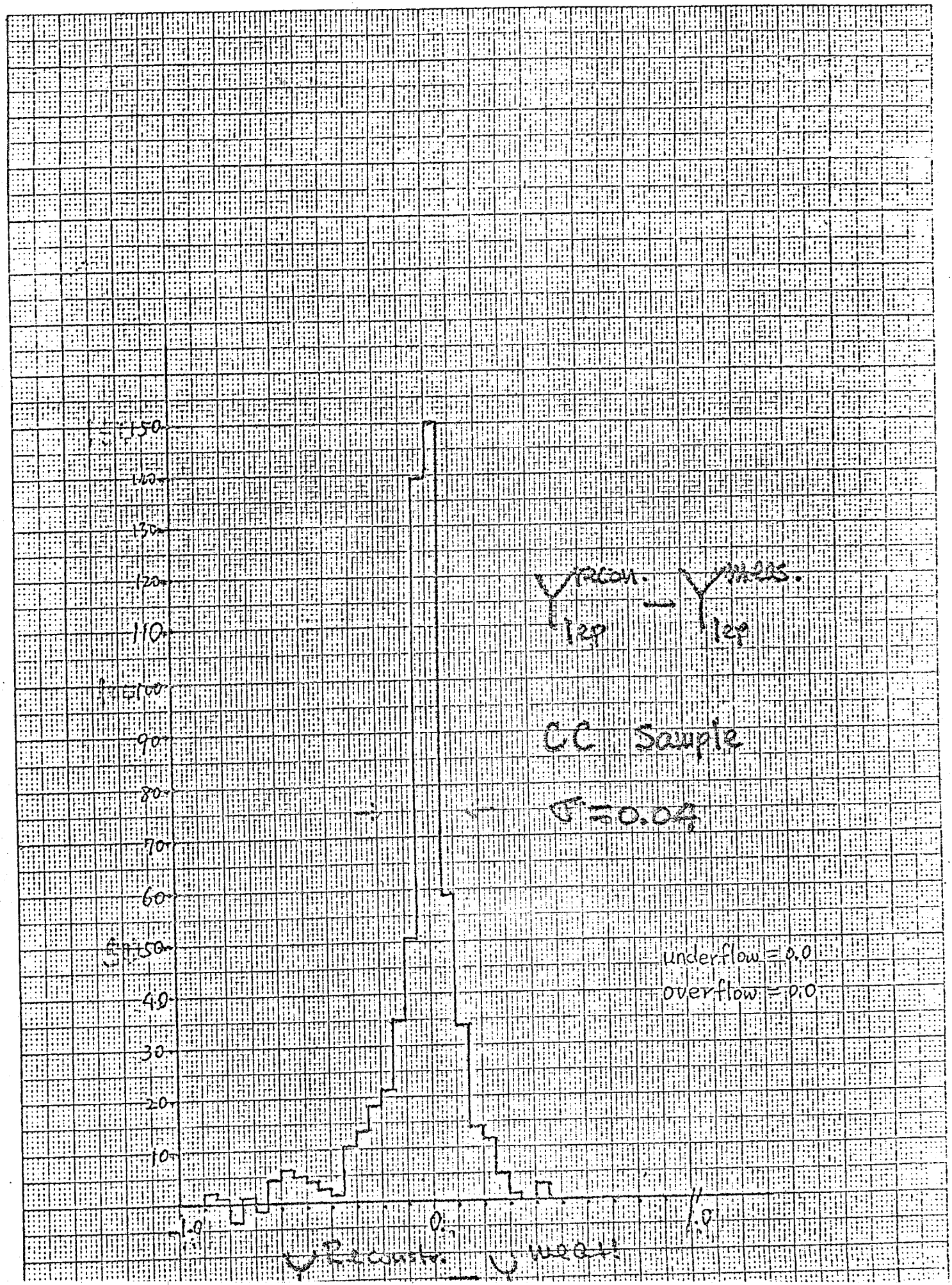
~~Ignore the measureable quantities~~ $E_{\mu}, \vec{P}_{\mu}$. We can reconstruct the outgoing lepton the same way as we do ν_{out} in NC.

$$E_{\mu} = E_{\nu_{in}} + m_p - E_{had}$$

$$\vec{P}_{\mu} = \vec{P}_{\nu_{in}} - \vec{P}_{had}$$



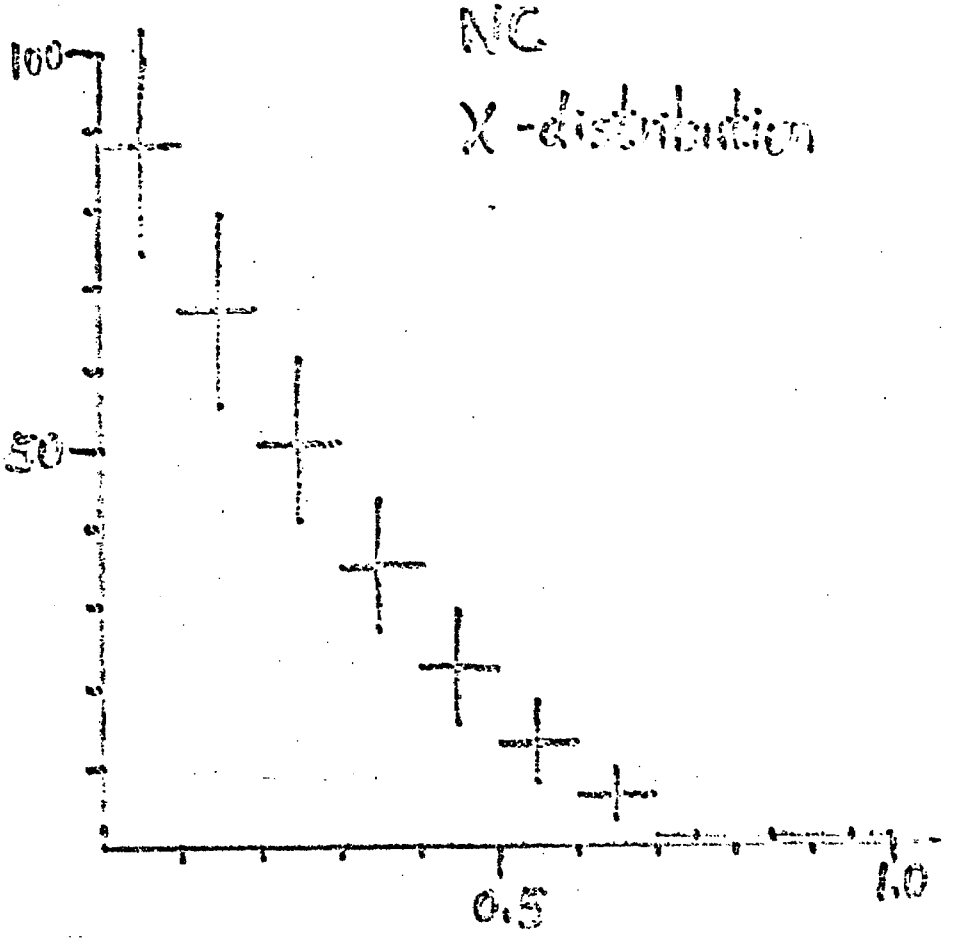

$X_{lep}^{recon} - X_{lep}^{meas}$
CC sample
$\sigma = 0.085$
underflow = 5.2
overflow = 13.3
100
90
80
70
60
50
40
30
20
10
-1.0
0
1.0
$(X_{\mu}^{reconstr.} - X_{\mu}^{meas})$


150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
-1.0
0.
1.0
CC Sample
σ = 0.04
underflow = 0.0
overflow = 0.0

(Neutral Current

NC

X-distribution



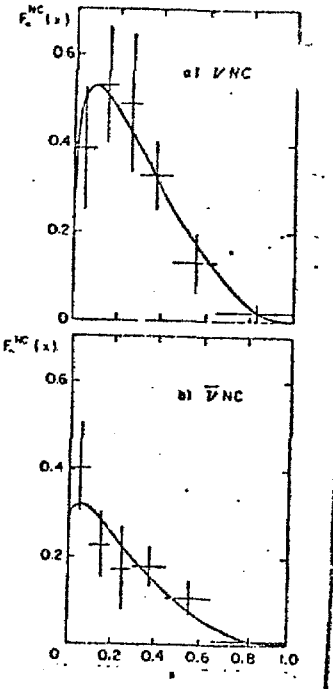
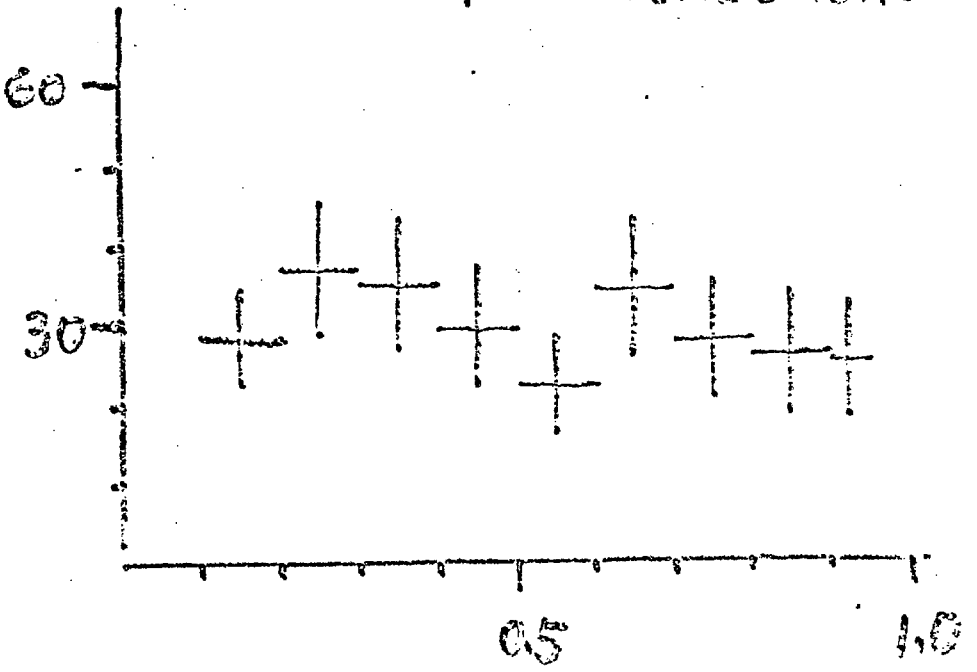


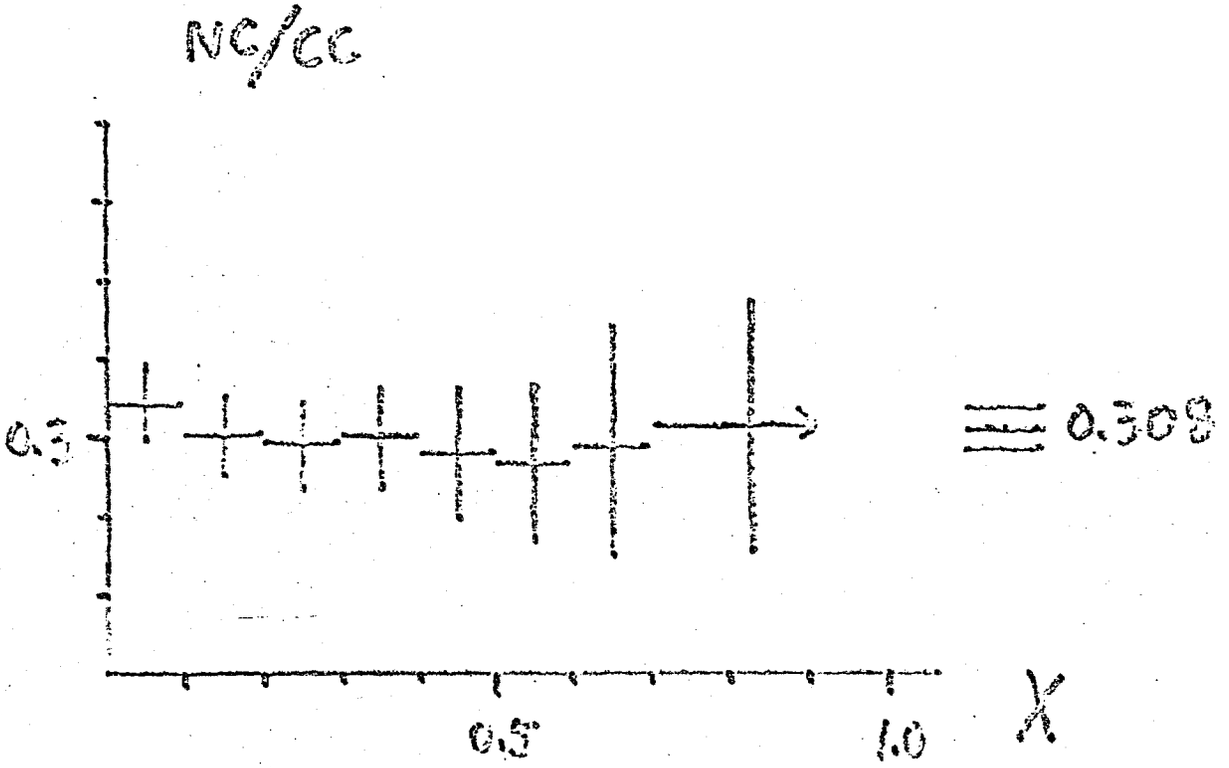
Fig. 10

Latest CHARM X-Dist. (Balaton ν Conf. 1982)

NC

Y-distribution.





$$\frac{\text{total NC}}{\text{total CC}} = 0.308 \pm 0.025$$

W. S. theory $\quad \sin^2\theta_w = 0.23$

$$\frac{NC}{CC} = 0.31$$